Brief summary of MIPs proposals related to systematic biases

Some context...

• CMIP and related MIPs form a foundation for the study of systematic errors in climate models
  
  • DECK simulations well suited for identifying and documenting errors
  
  • Additional experimentation often needed to sufficiently diagnose root causes
  
  • Some proposed CMIP6-MIPs provide such targeted experimentation (or augmented data request)
Brief summary of MIPs proposals related to systematic biases

MIPs with systematic errors ranked as highest priority

- **OCMIP** Ocean Carbon Cycle MIP
- **SensMIPs** (Parameter) Sensitivity MIP
- **LS3MIP** Land Surface, Snow and Soil Moisture MIP
- **GMMIP** Global Monsoons MIP
- **HiResMIP** High Resolution MIP

Diagnostic MIPs with systematic errors ranked as highest priority

- **CFMIP COSP**
- **DynVar**

Other MIP proposals with connections to systematic errors
OCMIP6  (Coordinator: James Orr)

To improve & accelerate development of ocean biogeochemical models (OBGCMs) via model evaluation & comparison

Plans within OCMIP6:
• Evaluate & compare coupled OBGCMs (CMIP6 DECK results)
• OGCM forced simulations with same OBGCMs (CORE forcing, 1958-2014)
• Evaluate circulation models with passive tracers, namely CFC's and SF6
• Compare intrinsic variability in coupled & forced simulations

Systematic errors to be addressed:
• Subsurface ventilation (simulated vs. observed CFCs & SF6)
• Mean state & annual cycle (compare to climatologies: WOA, GLODAP, ...)
• Trends & variability
  • compare to time-series stations
  • compare coupled vs. forced OBGCM (CORE reanalysis forcing)
HighResMIP

- Important weather and climate processes emerge at sub-50km resolution
- They contribute significantly to both large-scale circulation and local impacts, hence vital for understanding and constraining regional variability
- How robust are these effects?
- Is there any convergence with resolution across models?

Need **coordinated, simplified** experimental design to find out

**Experimental protocol:**
Global models – **AMIP-style and coupled**
Physical climate system only
Integrations: **1950-2050**
Ensemble size: >=1 (ideally 3)
Resolutions: **<25km HI and ~60-100km STD**
Aerosol concentrations specified

e.g. Zhao et al, 2009; Haarsma et al, 2013; Demory et al, 2013
Land Surface, Snow and Soil Moisture MIP (LS3MIP)

Addresses systematic biases as well as feedbacks

Relevant for several grand challenges
Benchmark for land surface models (DECK)

Diagnose land-atm feedback at annual and decadal time scale

Land-related predictability

Tier-2 experiments devoted to specific processes (snow depth, snow albedo, land use, ...)

<table>
<thead>
<tr>
<th>Name of MP</th>
<th>Proposed Experiment Name</th>
<th>Experiment Description / Design</th>
<th>Science Question and/or Gap Being Addressed with this Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSIMP</td>
<td>UMI-PHist</td>
<td>Land only simulations</td>
<td>Climate trend analysis</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-AGCM</td>
<td>Prescribed land conditions 1950-2014 climate AGCM</td>
<td>Diagnose land-climate feedback over land</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-AGCM</td>
<td>Prescribed land conditions 1950-2014 climate AGCM</td>
<td>Diagnose land-climate feedback including ocean response</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-AGCM</td>
<td>Prescribed land conditions 50yr running mean, AGCM</td>
<td>Diagnose land-climate feedback over land</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-AGCM</td>
<td>Prescribed land conditions 50yr running mean, AGCM</td>
<td>Diagnose land-climate feedback including ocean response</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-AGCM</td>
<td>Prescribed climate, AGCM</td>
<td>Response</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-AGCM</td>
<td>Prescribed land conditions 30yr running mean, AGCM</td>
<td>Diagnose land-climate feedback over land</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-AGCM</td>
<td>Prescribed land conditions 50yr running mean, AGCM</td>
<td>Diagnose land-climate feedback including ocean response</td>
</tr>
<tr>
<td>LSIMP</td>
<td>UMI-PHist-cut</td>
<td>Historical land only simulations with land</td>
<td>Assess landuse change impact on historic water,</td>
</tr>
</tbody>
</table>

LS3MIP: Planned experiments
Sensitivity Model Intercomparison Project (SensMIP)

D. Neelin, P. Gleckler, A. Bracco

• First step to address structural and parameterization errors in same framework (i.e., MME + PPE)

• Identify degree of sensitivity/nonlinearity typically associated with key hydrological processes (spatial diagnosis rarely emphasized in PPE)

• Tier 1: AMIP experiments

• Tier 2: Experiments addressing global warming sensitivity

• Based on established framework (Neelin et al., 2010)

• Simple design focusing on interpretable parameter dependencies (3-10) parameters associated with convective processes, precipitation formulation

• Computational costs moderate while permitting adequate statistical significance at each parameter point
Global Monsoons Modeling Inter-comparison Project (GMMIP)

**TASK-1:** Understanding 20th century changes of global monsoons
   - 4 additional historical simulations exp designs (3 coupled)

**TASK-2:** Interannual variability of global monsoon precipitations
   - 4 new coupled experiments

**TASK-3:** The role of Eurasian orography on the regional/global monsoons (Himalaya/Tibetan Plateau experiment)
   - 3 additional AMIP exps targeting orography sensitivity

**TASK-4:** High resolution modeling of global monsoons
   - Needs to be coordinated with HiResMIP
     - > 3000 years of simulation
Diagnostic MIPs

No new experiment only recommendation for changes to standard model output
CFMIP Observational Simulator Package (COSP) in CMIP6

Alejandro Bodas-Salcedo and Stephen Klein
Co-chairs of the COSP Project Management Committee

Why is COSP essential for CMIP6?

– Consistent evaluation of model clouds with satellite observations
– Diagnosis of response of clouds to greenhouse gases (and aerosols)
– Past achievements: 20+ papers analyzing COSP output in CMIP5/CFMIP2

COSP diagnostic request from CMIP6 DECK experiments

– Expanded (longer simulation periods) yet streamlined
– Simulators for additional satellites: MODIS + MISR
– Greater number of variables: Particle sizes and Cloud phase

Why will COSP be more successful?

– COSP code is ready now (unlike in CMIP5)
– COSP has been highly optimized and is faster than the CMIP5 version

COSP is a diagnostic code embedded into climate models that enables fairer comparison of a model’s clouds to satellite observations and clouds in other models

Bodas-Salcedo et al. (BAMS 2011)
Standard output requests for the DECK experiments

Include diagnostics of parameterized and resolved wave forcings, radiative and latent heating rates, better stratospheric resolution on daily time scale

Requesting archival of parameterized atmospheric gravity wave driving and of the Transformed Eulerian Mean (TEM) atmospheric circulation, allowing diagnosis of resolved wave driving and transport. Widely used in the analysis of the chemistry climate models (e.g. CCMVal and CCMI). 14 3D daily fields, all years for DECK exps except piControl (30yrs)

18 monthly means... non-trivial “Transformed Eulerian Mean diagnostic calculated from high frequency (6hr or shorter time intervals) in spherical, log-pressure coordinates”
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EP-divergence</td>
<td>ms(^{-1})d(^{-1})</td>
</tr>
<tr>
<td>1</td>
<td>u-tendency by vs advection</td>
<td>ms(^{-1})d(^{-1})</td>
</tr>
<tr>
<td>1</td>
<td>u-tendency by ws advection</td>
<td>ms(^{-1})d(^{-1})</td>
</tr>
<tr>
<td>1</td>
<td>u-tendency by orographic gw</td>
<td>ms(^{-1})d(^{-1})</td>
</tr>
<tr>
<td>1</td>
<td>v-tendency by orographic gw</td>
<td>ms(^{-1})d(^{-1})</td>
</tr>
<tr>
<td>1</td>
<td>u-tendency by non-orographic gw</td>
<td>ms(^{-1})d(^{-1})</td>
</tr>
<tr>
<td>1</td>
<td>v-tendency by non-orographic gw</td>
<td>ms(^{-1})d(^{-1})</td>
</tr>
</tbody>
</table>


Monthly zonal mean of zonal tendency by orographic gravity wave parameterization

Monthly zonal mean of meridional tendency by orographic gravity wave parameterization

Monthly zonal mean of zonal tendency by non-orographic gravity wave parameterization

Monthly zonal mean of meridional tendency by non-orographic gravity wave parameterization
Synthesis: Criteria for MIPs to be endorsed for CMIP6

- Addresses at least one key science question of CMIP6 – yes for all
- Builds on the shared CMIP DECK experiments – yes
- Follows CMIP standards – presumably yes
- Commitment to analyze – yes
- Timeframe – coincident with CMIP6

- A sufficient number of modeling groups have agreed to participate in the MIP? Mixed results

- The proposed experiment has been run at least by two modeling groups already
Types questions that need to be addressed (examples)

• OCMIP coordination with OMIP (not yet proposed)

• SensMIP necessary to make data widely available?

• HiResMIP *coupled* simulations (Tier 1 and Tier 2)

• GS3MIP and GMMIP complex experimental design – how many experiments to include as part of CMIP6?

• If Diagnostic MIPs are included in DECK are they mandatory?
END